CHEMISTRY INDUSTRY ASSOCIATION OF CANADA

FROM MOLECULES TO MINES

Chemistry at the Heart of Canadian Mining Industry

Chemicals play a crucial and multifaceted role throughout the **mining**, **refining**, **and production** stages of critical mineral development. These roles are essential for ensuring efficiency, product quality, and environmental compliance. After all, **they're just rocks without chemistry**.

Critical minerals are the unseen building blocks of our modern lives—powering everything from smartphones and electric vehicles to renewable energy systems and national defense technologies. These minerals play a vital role in supporting the everyday conveniences and essential services we depend on.

CHEMISTRY AND MINING:
DRIVING CANADA'S ECONOMY

Chemicals are essential enablers across the value chain of critical mineral development—from extraction and refinement to final product manufacturing and environmental stewardship. Their proper use ensures not only the economic viability of operations but also minimizes environmental impact and enhances resource efficiency.

The mining industry is the bedrock of Canada's economy:

Employing 403,000 Canadians

Adding **$125 billion** to Canada's GDP

WHAT ARE CRITICAL MINERALS?

Critical minerals are essential raw materials used in technologies that power modern life, from clean energy to electronics and transportation. Minerals like lithium, graphite, and cobalt are key for electric vehicle batteries, while rare earth elements, gallium, and germanium are crucial for electronics and renewable energy systems. Others like titanium, aluminium, and platinum support aerospace, automotive, and industrial applications. With growing demand and limited global supply, these minerals are vital to both economic growth and the shift to a low-carbon future.

MINING OF CRITICAL MINERALS

Ore Extraction

- **Explosives and Blasting Agents:** Chemicals like ammonium nitrate-fuel oil (ANFO) are used for rock fragmentation in hard-rock mining.
- Drilling Fluids and Lubricants: Synthetic and natural polymers help reduce friction, cool drilling equipment, and stabilize boreholes.

Ore Beneficiation

- **Flotation Agents:** Collectors (e.g., xanthates), frothers, and depressants are used in froth flotation to selectively separate valuable minerals from waste rock.
- **pH Modifiers:** Lime or sulfuric acid is used to optimize the chemical environment for efficient separation.

REFINING AND PROCESSING

Hydrometallurgical Processing

Leaching Agents:

- **Sulfuric acid:** Common in nickel and cobalt extraction.
- **Hydrochloric acid or ammonia:** Used in rare earth element leaching.
- **Cyanide:** Widely used in gold processing.

Solvent Extraction and Ion Exchange:

- **Organic solvents and extractants (e.g., tributyl phosphate for rare earths):** Selectively separate metals from solution.
- **Precipitating Agents:** Chemicals like oxalic acid or lime help recover metals by turning them into solid form.

Pyrometallurgical Processing

- **Fluxes (e.g., silica, limestone):** Added during smelting to bind impurities and form slag.
- **Reductants:** Coke, hydrogen, or other reducing agents are used to convert metal oxides into pure metals.

PRODUCTION AND MANUFACTURING

Alloying and Purification

- **Chemical Additives:** Used to enhance mechanical properties of alloys (e.g., adding phosphorus or boron in neodymium-iron-boron magnets).
- **Electrolytes and Electrorefining Chemicals:** High-purity chemicals used in electrolysis for refining metals like copper, lithium, and cobalt.

Battery-Grade Materials

- **Lithium Compounds:** Lithium carbonate and lithium hydroxide are refined using chemical treatments for battery cathode production.
- **Binders, Solvents, and Conductive Additives:** Used in the production of lithium-ion battery electrodes (e.g., PVDF binder, NMP solvent).

ENVIRONMENTAL AND WASTE MANAGEMENT

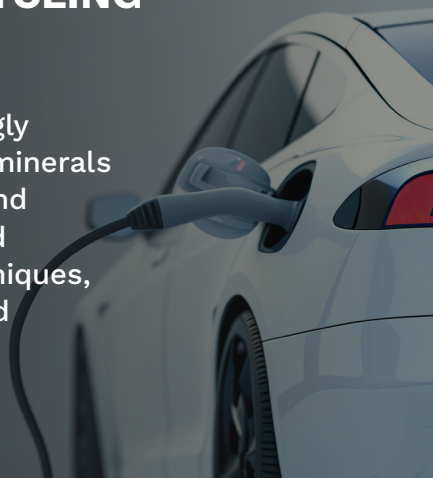
Neutralization Agents: Lime or caustic soda is used to neutralize acidic mine drainage.

Water Treatment Chemicals: Flocculants, coagulants, and biocides help treat process water and tailings.

Dust Suppressants and Soil Stabilizers: Used in mining operations to reduce particulate emissions and erosion.

CIRCULAR ECONOMY AND RECYCLING

Chemicals are increasingly used to recover critical minerals from electronic waste and batteries using advanced hydrometallurgical techniques, including bioleaching and solvent extraction.



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